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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	SIP-106-A	*Total Pages*	92
First Named Inventor or Application Identifier	Ozawa		
Express Mail Label No.	EM441303695US		

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

1. [XX] Fee Transmittal Form *(Submit an original, and a duplicate for fee processing)*
2. [XX] Specification [Total Pages: 25] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [XX] Drawing(s) *(35 USC 113)* [Total Sheets: 10]
4. Oath or Declaration [Total Pages: 35]
   - a. [XX] Newly executed (original or copy)
   - b. [ ] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 17 completed)* *[Note Box 5 below]*
     - i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. [ ] Incorporation By Reference *(useable if Box 4b is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   - a. [ ] Computer Readable Copy
   - b. [ ] Paper Copy (identical to computer copy)
   - c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [XX] Assignment Papers (cover sheet & document(s))
9. [ ] 37 CFR 3.73(b) Statement [ ] Power of Attorney *(when there is an assignee)*
10. [ ] English Translation Document *(if applicable)*
11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [XX] Preliminary Amendment
13. [XX] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [ ] Small Entity Statement(s) [ ] Statement filed in prior application, Status still proper and desired
15. [XX] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Other: .....

17. **If a CONTINUING APPLICATION,** *check appropriate box and supply the requisite information:*
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Our Ref. SIP-106-A

Box Patent Application
Assistant Commissioner For Patents
Washington, D.C. 20231

19 July 2000

Sir:

Enclosed please find an application for U.S. Letters Patent as identified below:

Inventors: Masaru OZAWA, Takeo FUKUDA
Invention: STATOR WINDING AND MANU-FACTURING METHOD THEREFOR

and including: Specification, Claims and Abstract; Formal Drawings - ten (10) sheets; Declaration and Power Of Attorney; Preliminary Amendment-A; Assignment; and Certified Priority Document. This application claims Convention priority from Japanese Patent Application 11-211395 filed 26 July 1999.

Basic Fee	$690.00
0 claims over 20 x $18.00	0.00
0 independent claims over 3 x $78.00	0.00
TOTAL FILING FEE:	$690.00

Check No. 1785 for $690.00 is enclosed herewith in payment of the filing fee. The Commissioner is hereby authorized to charge any deficiency which may be required during the entire pendency of the application, or to credit any excess paid during the entire pendency of the application, to Deposit Account 50-0744 in the name of Carrier, Blackman & Associates, P.C. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

Joseph P. Carrier
Attorney for Applicant
Registration No. 31,748
(248) 344-4422

Customer Number 21828
Carrier, Blackman & Associates, P.C.
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19 July 2000

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Dated: 19 July 2000
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Erica Briggs

SIP-106-A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	M. Ozawa
Serial No.:	Unknown
Filed:	Concurrently herewith
Group Art Unit:	Unknown
Examiner:	Unknown
Title:	STATOR WINDING AND MANUFACTURING METHOD THEREFOR

PRELIMINARY AMENDMENT-A

Box Patent Applications
Assistant Commissioner for Patents
Washington, DC 20231

Sir:

In connection with the subject new patent application (filed concurrently herewith), please amend the application as follows.

IN THE SPECIFICATION:

Page 2, line 10, change "order to cope" to --coping--;

line 23, change "shape" to --shaped--.

Page 3, line 2, change "shape" (both occurrences) to --shaped--;

line 2, change "shape" (both occurrences) to --shaped--;

line 6, change "shape" to --shaped--;

line 7, change "shape" to --shaped--;

line 8, after "also" insert a comma;

line 19, change "approximate" to --approximately--;

line 20, change "approximate" to --approximately--; change "shape" to --shaped--;

line 22, change "the" (first occurrence only) to --a--.

Page 4, line 1, change "shape" to --shaped--;

line 4, change "is" to --segments are each--;

line 5, after "coil" insert --segment--;

line 12, after "side" insert --thereof--; change "an" (second occurrence only) to --the--;

line 13, after "side" insert --of the hollow cylindrical body--;

line 14 before the period insert --thereof--;

line 15 after "portions" insert --thereof--.

Page 5, line 2, after"direction" insert --of the hollow cylindrical body--;

line 6, before the period insert --of the entire windings;

line 9, change "approximate" to --approximately--; change "shape" to --shaped--;

line 16, before the first occurring comma insert --thereof--; after "peripheral" insert --side--;

line 23, after "side" insert --of the hollow cylindrical body--.

Page 6, line 1, after "sides" insert --of the respective coil segments--;

lines 1-2, change "respective coil segments" to --hollow cylindrical body--;

line 3, after "sides" insert --of the respective coil segments--; change "respective coil segments" to --hollow cylindrical body--;

line 20, change "approximate" to --approximately--; change "shape" to --shaped--.

Page 7, line 2, after "of" insert a comma; after "for example" insert a comma;

line 11, change "With the" to --A--;

line 12, change "then with a method of manufacturing a" to --which--; after "winding" insert --may be--;

line 13, change "which incorporates" to --comprises steps of--;

line 15, change "approximate" to --approximately--;

line 19, change "shape" (second occurrence only) to --shaped--;

line 22, change "shape" (first occurrence only) to --shaped--; change "; the" to --. The--; after "where" insert a comma.

Page 8, line 2, before the comma insert --thereof--;

line 3, after "side" (first occurrence only) insert --of the hollow cylindrical body--; before the period insert --thereof--;

line 7, change "which" to --each said bent back portion--;

line 8, before the period insert --of the turn--;

line 10, before the period insert --together--;

line 17, change "approximate" to --approximately--; change "shape" to --shaped--.

Page 10, line 1, change "shape" (both occurrences) to --shaped--;

line 4, change "shape" to --shaped--.

Page 11, line 17, change "shape" to --shaped--.

Page 12, line 2, change "magnet" to --magnetic--;

line 3, change "magnet" to --magnetic--;

line 11, change "magnet" to --magnetic--;

line 18, change "approximate" to --approximately--.

Page 13, line 12, change "approximate" to --approximately--; change "shape" to --shaped--.

Page 14, line 2, change "shape" to --shaped--;

line 3, change "magnet" to --magnetic--;

line 4, change "cross-section" to --cross-sectional--;

line 5, change "approximate" to --approximately--;

line 6, change "magnet" to --magnetic--;

line 17, after "direction" insert --or in the direction of the other diagonal--;

line 20, after "side" insert --of the hollow cylindrical body--;

line 23, after "side" insert --of the hollow cylindrical body--.

Page 15, line 5, change "magnet" to --magnetic--;

line 11, change "magnet" to --magnetic--;

line 15, change "approximate" to --approximately--; change "shape" to --shaped--;

line 21, change "shape" to --shaped--;

line 23, change "shape" to --shaped--.

Page 16, line 8, change "magnet" to --magnetic--; after "Since" insert a comma; after "way" insert a comma;

line 9, change "magnet" to --magnetic--.

Page 17, line 23, after "side" (first occurrence only) insert --of the hollow cylindrical body--; after "side" (second occurrence only) insert --thereof--;

lines 6-7, delete "coil segment";

line 19, change "magnet" to --magnetic--;

line 20, change "magnet" to --magnetic--.

Page 18, line 8, change "magnet" to --magnetic--;

line 9, change "magnet" to --magnetic--;

line 11, change "cross-section" to --cross-sectional--;

line 15, change "magnet" to --magnetic--;

line 17, change "magnet wire 24" to --magnetic wire 25--.

Page 19, line 18, after the period insert the paragraph

--Although there have been described what are at present considered to be the preferred embodiments of the invention, it will be understood that variations and modifications may be made thereto without departing from the gist or essence of the invention. The scope of the invention is indicated by the appended claims.--.

IN THE CLAIMS:

Please amend the claims as follows.

1. (amended) A stator winding for use in a rotating electric machine having a slotless stator, said stator winding being a hollow cylindrical body formed by:

forming turns by winding a wire sheaf of a plurality of fine wires composed of conductors bundled together, through one turn in an [approximate] approximately rhombic shape;

forming [approximate] approximately rhombic [shape] shaped coil segments comprising a continuous length of said wire sheaf by winding and arranging a plurality of said turns so as to be sequentially shifted continuously in [the] a direction of one diagonal of said rhombic shape[,];

forming a band [shape] shaped body using a plurality of said coil segments with these coil

segments sequentially shifted in the direction of said one diagonal and so as to be adjacent to each other[,]; and

rolling said band [shape] shaped body into a hollow cylindrical shape.

2. (amended) A stator winding according to claim 1, wherein with said wire sheaf, one end portion of opposite end portions of said respective turns which are located in [the] a direction of another diagonal of said rhombic shape orthogonal to the direction of said one diagonal is wound from an inner peripheral side of said hollow cylindrical body to an outer peripheral side thereof, and another end portion of said opposite end portions of said respective turns, is wound from the outer peripheral side of said hollow cylindrical body to the inner peripheral side thereof.

3. (amended) A stator winding according to [either one of] claim 1 [and claim 2], wherein with said respective turns, opposite end portions which are located in [the] a direction of another diagonal of said rhombic shape orthogonal to the direction of said one diagonal, have bent back portions which proceed so as to project towards an outside of said turn, and then return back in an [approximate] approximately U-shape and proceed so as to return towards an inside of said turn.

4. (amended) A stator winding according to [any one of] claim 1 [through claim 3], wherein said respective turns are arranged [in a condition] touching adjacent ones of said turns.

5. (amended) A stator winding according to [any one of] claim 2 [1 through claim 4], wherein of the four sides of said [approximate] approximately rhombic [shape] shaped coil segments, two said sides located on one side of said other diagonal of said rhombic shape are arranged on an inner peripheral side of said hollow cylindrical body, and the other two said sides opposite to the two said sides located on said one side are arranged on an outer peripheral side

of said hollow cylindrical body.

6. (amended) A stator winding according to claim 5, wherein the two sides of the coil segment which are arranged on the inner peripheral side of said hollow cylindrical body are abutted in the circumferential direction against said two sides which are arranged on the inner peripheral side of the [adjacent] coil segment adjacent thereto.

7. (amended) A stator winding according to [any one of claim 2 through] claim [6] 3, wherein said bent back portions are bent from the inner peripheral side of said hollow cylindrical body towards the outer peripheral side thereof, or from the outer peripheral side of said hollow cylindrical body towards the inner peripheral side thereof.

Claim 8, line 1, delete "any one of"; delete "through claim 7";

line 3, change "shape" to --shaped--.

Claim 9, line 1, delete "any one of"; delete "through claim 8";

line 2, change "shape" to --shaped--.

Claim 10, line 1, delete "any one of"; delete "through claim 9";

line 3, after "contacted" insert --together--.

11. (amended) A method of manufacturing a stator winding [wherein with a method of manufacturing a stator winding used] for use in a rotating electric machine having a slotless stator, [which incorporates] said method comprising:

a turn forming step for forming turns by winding a wire sheaf of a plurality of fine wires composed of conductors bundled together, through one turn in an [approximate] approximately rhombic shape;

a coil segment forming step for forming approximately rhombic shaped coil segments

comprising a continuous length of said wire sheaf by winding and arranging a plurality of said turns so as to be sequentially shifted continuously in [the] a direction of one diagonal of said rhombic shape; and

a hollow cylindrical body forming step for forming a band [shape] shaped body using a plurality of said coil segments by overlapping these coil segments so as to be sequentially shifted in the direction of said one diagonal and adjacent to each other, and rolling said band [shape] shaped body into a hollow cylindrical shape,

said turn forming step includes a step where, with said wire sheaf, one end portion of opposite end portions of said respective turns which are located in [the] a direction of another diagonal orthogonal to the direction of said one diagonal is wound from an inner peripheral side of said hollow cylindrical body to an outer peripheral side thereof, and another end portion of said opposite end portions of said respective turns, is wound from the outer peripheral side of said hollow cylindrical body to the inner peripheral side thereof.

12. (amended) A method of manufacturing a stator winding according to claim 11, wherein said turn forming step [incorporates] further includes a bent back portion forming step for forming bent back portions at said opposite end portions of said respective turns which are located in the direction of the other diagonal orthogonal to the direction of said one diagonal, [which] such that each said bent back portion proceeds so as to project towards an outside of said turn, and then returns back in an [approximate] approximately U-shape and proceed so as to return towards an inside of said turn.

Claim 13, line 1, delete "either one of";

line 2, delete "and claim 12";

line 3, before the period insert --together--.

14. (amended) A method of manufacturing a stator winding according to claim 13, [wherein] further including, prior to said press step [there is provided], a step [for] of twisting said wire sheaf at least one turn in a helical form within a range of one side of said [approximate] approximately rhombic [shape] shaped turn.

Claim 15, line 1, delete "either one of";

line 2, delete "and claim 14".

Please add the following new claims.

16. (new) A stator winding according to claim 2, wherein with said respective turns, opposite end portions which are located in a direction of another diagonal of said rhombic shape orthogonal to the direction of said one diagonal, have bent back portions which proceed so as to project towards an outside of said turn, and then return back in an approximately U-shape and proceed so as to return towards an inside of said turn.

17. (new) A stator winding according to claim 3, wherein of the four sides of said approximately rhombic shaped coil segments, two said sides located on one side of said other diagonal of said rhombic shape are arranged on an inner peripheral side of said hollow cylindrical body, and the other two said sides opposite to the two said sides located on said one side are arranged on an outer peripheral side of said hollow cylindrical body.

18. (new) A stator winding for use in a rotating electric machine having a slotless stator, comprising a band shaped body of a plurality of coil segments rolled into a hollow cylindrical shape, wherein:

each of said coil segments is approximately rhombic shaped and includes a continuous

length of a wire sheaf wound and arranged into a plurality of turns which are sequentially shifted continuously in a direction of one diagonal of said rhombic shape;

each of said turns is also approximately rhombic shaped;

said wire sheaf includes a plurality of fine wires composed of conductors bundled together; and

said plurality of said coil segments of said band shaped body are sequentially shifted in the direction of said one diagonal and so as to be adjacent to each other.

19. (new) A stator winding according to claim 18, wherein with said wire sheaf, one end portion of opposite end portions of respective ones of said turns which are located in a direction of another diagonal of said rhombic shape orthogonal to the direction of said one diagonal is wound from an inner peripheral side of said hollow cylindrical body to an outer peripheral side thereof, and another end portion of said opposite end portions of said respective turns, is wound from the outer peripheral side of said hollow cylindrical body to the inner peripheral side thereof.

20. (new) A stator winding according to claim 18, wherein with respective ones of said turns, opposite end portions thereof which are located in a direction of another diagonal of said rhombic shape orthogonal to the direction of said one diagonal, have bent back portions which proceed so as to project towards an outside of said turn, and then return back in an approximately U-shape and proceed so as to return towards an inside of said turn.

IN THE ABSTRACT:

Line 2, change "To provide a" to --A--;

Lines 2-3, change ", then with a stator winding," to --includes--;

Line 4, change "approximate" to --approximately--; before "are" insert --wherein the

turns--;

Line 6, change "approximate" to --approximately--;

Line 8, change "shape" to --shaped--;

Line 9, change "shape" to --shaped--.

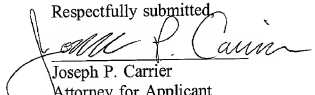
REMARKS

Upon entry of the present Preliminary Amendment-A the claims in the application are claims 1-20, of which claims 1, 11 and 18 are independent.

The specification, claims and abstract have been amended to overcome minor informalities therein, the claims have been amended to eliminate multiple dependencies therein, and new claims 16-20 added to further define aspects of the invention (noting that claim 15 is similar to claim 3, but depends from claim 2; claim 17 is similar to claim 5, but depends from claim 3; and new claims 18-20 are similar to claims 1-3). Applicant respectfully submits that the amendments are fully supported by the original application.

Favorable consideration is respectfully requested.

Respectfully submitted,



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July 19, 2000

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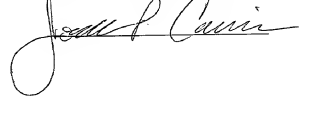

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STATOR WINDING AND MANUFACTURING METHOD THEREFOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a stator winding which is suitable for use in a rotating electrical machine such as an electric motor or generator, and more specifically which is suitable for use in a slotless stator of a high speed rotating electrical machine, and to a manufacturing method therefor.

This application is based on Japanese Patent Application No. Hei 11-211395, the contents of which are incorporated herein by reference.

Description of the Related Art

Heretofore, there has been proposed a slotless stator where, from the viewpoint of making even the magnetic resistance of the main magnetic flux path as viewed from the stator side, a slot is not formed. A radial gap type slotless construction where cylindrical windings are secured to an inner peripheral side of a slotless stator which faces a rotor, is widely used.

Such a radial gap type slotless construction is disclosed in the specification of U.S. Patent No. 5,313,131.

FIG. 13 is a perspective view showing an end portion of a slotless stator. A plurality of coil segments 103 are secured to an inner peripheral face of a stator core 101. These coil segments 103, as shown in FIG. 14, bear an approximate quadrilateral shape

with rounded corners . When these coil segments 103 are used, this gives a construction, as can be seen from FIG. 13, where one side 105 of the quadrilateral shape is exposed from the edge portion of the stator core 101.

If one side of the coil segment is exposed, then the amount of the winding for that part is wastefully used. This increases the resistance value of the windings and produces heat. In the case where this is used in a high speed electric motor with the speed reaching for example several tens of thousand rpm, such heat cannot be disregarded.

Furthermore, if the number of turns of the coil is increased, then the amount exposed from the stator increases accordingly. Moreover, the less the number of poles the longer the span length exposed from the stator end. Furthermore, in order to cope with a high output brings the requirement for arranging conductors compatible with high currents. In such a case, the size of the coil in the axial direction or in the diametral direction is increased, so that the rotating electrical machine itself is enlarged. That is to say, there is the problem that when the conductor amount is increased to realize the high output, the rotating electrical machine is enlarged.

In particular, in the case where the stator coil is enlarged in the axial direction, then corresponding to this the rotor is also enlarged in the axial direction. This has a significant influence on the centrifugal strength and shaft vibration of the rotor. Consequently, there is a strong demand for miniaturizing the stator coil as much as possible particularly in the axial direction.

As another shape for the abovementioned approximate quadrilateral shape coil segment, there is proposed in Japanese Patent Application, Second Publication No. Sho 53-44362 a coil having rhombic shape turns.

FIG. 15 shows a band shape coil 111 formed by sequentially aligning rhombic shape turns . FIG. 16 shows a cylindrical shape coil 113 formed by rolling the band shape coil 111 of FIG. 15. With such a cylindrical shape coil 113, since apexes of the rhombic shapes are located at opposite ends of the cylindrical body, the amount of windings exposed from the stator can be kept to a minimum.

With the form of FIG. 15 however, the band shape coil comprising rhombic shape turns is formed from single wires, and is not possible to make this a multi-layered cylindrical coil which is a necessity in order to obtain a high output. In this case also even if this is parallel connected, phase matching is difficult, and there is the problem that if these are laminated in several layers, the coil thickness increases.

SUMMARY OF THE INVENTION

Accordingly, the present invention takes into consideration the above problems with the object of providing a slotless stator which addresses the realization of high output and also miniaturization. Moreover, it is an object to provide a method of manufacturing a stator winding which is simple and has good formability.

The above objects are achieved by the following means.

The stator winding of the present invention is characterized in being a hollow cylindrical body formed by: forming turns by winding a wire sheaf of a plurality of fine wires composed of conductors bundled together, through one turn in an approximate rhombic shape; forming approximate rhombic shape coil segments comprising a continuous length of the wire sheaves by winding and arranging a plurality of the turns so as to be sequentially shifted continuously in the direction of one diagonal of the

rhombic shape, forming a band shape body using a plurality of the coil segments with these coil segments sequentially shifted in the direction of the one diagonal and so as to be adjacent to each other, and rolling the band shape body into a cylindrical shape.

Since the coil is formed from a wire sheaf comprising a plurality of fine wires, then compared to a coil formed from a single wire, this can be made to cope with higher speed rotation. Moreover, with the wire sheaf, by pressing this using a press, an increase in the thickness of the coil can be avoided, and by twisting together, circulating current losses are reduced.

The wire sheaf is characterized in that one end portion of opposite end portions of the respective turns which are located in the direction of an other diagonal orthogonal to the direction of the one diagonal is wound from an inner peripheral side of the hollow cylindrical body to an outer peripheral side, and an other end portion of the opposite end portions of the respective turns, is wound from the outer peripheral side to the inner peripheral side.

The respective turns are characterized in that opposite end portions which are located in the direction of an other diagonal orthogonal to the direction of the one diagonal, have bent back portions which proceed so as to project to an outside of the turn, and then return back in an approximate U-shape and proceed so as to return to an inside.

By locating the bent back portions on the end portions of the hollow cylindrical body, these bent back portion face in the direction of the other diagonal of the rhombic shape, that is to say in the longitudinal (axis) direction of the hollow cylindrical body. As a result, the bent back portions can be compactly arranged around the circumferential direction of the hollow cylindrical body, so that a plurality of turns can be closely wound. Consequently, even if the number of turns is increased, the bent back portions are

laminated side by side, and these bent back portions are not exposed extending in the radial direction or the axial direction.

When the windings according to the present invention are secured to the core of the slotless stator, only the bent back portions of the respective turns are exposed from the end of the stator. That is to say, the portion exposed from the core is only the bent back portions and is only a little. Hence the winding amount is considerably reduced.

Preferably the respective turns are arranged in a condition touching adjacent turns. In this way, a winding wound at a high density can be formed.

More preferably, of the four sides of the approximate rhombic shape coil segments, two sides located on one side of the other diagonal are arranged on an inner peripheral side of the hollow cylindrical body, and the other two sides opposite to the two sides located on the one side are arranged on an outer peripheral side of the hollow cylindrical body.

Since two sides of the coil segment are arranged on the inner peripheral side of the hollow cylindrical body, and the other two sides are arranged on the outer peripheral side, then on both the inner peripheral side and the outer peripheral, the wire sheaves are closely arranged.

Even more preferably, the two sides of the coil segment which are arranged on the inner peripheral side of the hollow cylindrical body are abutted in the circumferential direction against the two sides which are arranged on the inner peripheral side of the adjacent coil segment, and the respective coil segments are arranged sequentially shifted while being overlapped so as to radially overlap the two sides of the adjacent coil segments, which are arranged on the outer peripheral side.

The two sides which are arranged on the inner peripheral side of the respective coil segments are uniformly arranged in the circumferential direction. Furthermore, the two sides which are arranged on the outer peripheral side of the respective coil segments overlap the two sides arranged on the inner peripheral side of the adjacent coil segment, in the radial direction of the hollow cylindrical body . In so doing, the respective coil segments are arranged in an alternately overlapped fashion. As a result, the plurality of coil segments are closely overlapped in the circumferential direction and the diametral direction.

More preferably, with the bent back portions located on the opposite ends of the respective turns, one end side thereof is bent from the inner peripheral side of the hollow cylindrical body towards the outer peripheral side, and/or the other end side is bent from the outer peripheral side towards the inner peripheral side.

Since the bent back portions are bent from the inner peripheral side (outer peripheral side) to the outer peripheral side (inner peripheral side), the bent back portions can be arranged closely in the circumferential direction. As a result, the respective turn sets can be arranged sequentially and in close contact in the circumferential direction. That is to say, even if the number of turns of increased, the winding is not enlarged in the axial direction and the diametral direction.

More preferably, the wire sheaf is twisted at least one turn in a helical form within a range of one side of the respective approximate rhombic shape turns.

Twisting in a helical shape gives a construction the same as a Litz wire used for example in high frequency transformers. Hence the electromotive voltage difference which is produced in the respective strands in the wire sheaf forming the turns can be

reduced, and the generation of unnecessary losses of for example circulating currents can be suppressed.

More preferably, the wire sheaf has an approximately rectangular shape cross-section.

When wire sheaves having rectangular cross-sections are arranged adjacent to each other, these wire sheaves can be arranged in a close contact condition, thereby increasing the conductor space factor of the coil segment.

More preferably, the fine wires have a distorted circular cross-section with linear portions, and adjacent fine wires are contacted at the linear portions.

In this way, the conductor space factor is further increased.

With the method of manufacturing a stator winding according to the present invention, then with a method of manufacturing a stator winding used in a rotating electric machine having a slotless stator, which incorporates:

a turn forming step for forming turns by winding a wire sheaf of a plurality of fine wires composed of conductors bundled together, through one turn in an approximate rhombic shape; a coil segment forming step for forming coil segments comprising a continuous length of the wire sheaf by winding and arranging a plurality of the turns so as to be sequentially shifted continuously in the direction of one diagonal of the rhombic shape; and a hollow cylindrical body forming step for forming a band shape body using a plurality of the coil segments by sequentially shifting and overlapping these coil segments so as to be adjacent in the direction of the one diagonal, and rolling the band shape body into a hollow cylindrical shape, the turn forming step includes a step where with the wire sheaf, one end portion of opposite end portions of the respective turns which are located in the direction of an other diagonal orthogonal to the direction of the

one diagonal is wound from an inner peripheral side of the hollow cylindrical body to an outer peripheral side, and an other end portion of the opposite end portions of the respective turns, is wound from the outer peripheral side to the inner peripheral side.

The turn forming step is characterized in incorporating a bent back portion forming step for forming bent back portions at opposite end portions of the respective turns which are located in the direction of the other diagonal orthogonal to the direction of the one diagonal, which proceeds so as to project to an outside of the turn, and then returns back in an approximate U-shape and proceeds so as to return to an inside.

Preferably, the turn forming step incorporates a press step for pressing the wire sheaf so that adjacent fine wires are closely contacted.

By pressing, the respective fine wires constituting the wire sheaf are deformed to a close contact condition. Furthermore, by keeping the respective fine wires in a close contact condition in this way , the cross-sectional shape of the wire sheaf can be stably maintained.

More preferably, prior to the press step there is provided a step for twisting the wire sheaf at least one turn in a helical form within a range of one side of the approximate rhombic shape turn.

By carry out pressing after applying a twist, the respective fine wires are deformed in a twisted condition, and hence a more rigid close contact condition is obtained.

More preferably, the press step incorporates a step for forming the wire sheaf so that the wire sheaf has an approximately rectangular cross-section.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view showing a rotating electric machine provided with a stator winding according to an embodiment of the present invention.

FIG. 2 is a sectional view on the section line II-II of FIG. 1.

FIG. 3 is a plan view showing a condition where a hollow cylindrical body formed from a plurality of coil segments is developed into a plane.

FIG. 4 is a plan view showing a coil segment.

FIG. 5 is a perspective view showing a coil segment.

FIG. 6 is an enlarged perspective view showing a wire sheaf which forms the coil segment.

FIG. 7 is a cross-sectional view showing a cross-sectional shape of fine wires which make up the wire sheaf.

FIG. 8 is a perspective view showing an arrangement condition of the coil segments.

FIG. 9 is a perspective view showing a stator winding according to the present invention in the form of a hollow cylindrical body.

FIG. 10 is a perspective view showing a condition where the stator winding is inserted into a stator core.

FIG. 11 is a perspective view showing a stator core with a divided construction.

FIG. 12 is a plan view showing a modified example of extended portions of turns.

FIG. 13 is a perspective view showing a slotless stator according to conventional technology.

FIG. 14 is a perspective view showing a coil segment used in the slotless stator of FIG. 13.

FIG. 15 is a plan view showing a band shape coil having rhombic shape turns according to conventional technology.

FIG. 16 is a perspective view showing a cylindrical coil formed by rolling the band shape coil of FIG. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereunder is a description of embodiments of the present invention with reference to the appended drawings.

FIG. 1 is a cross-sectional view showing a rotating electrical machine provided with a stator winding being one embodiment of the present invention.

FIG. 2 is a sectional view on the section line II-II of FIG. 1.

A rotating electrical machine 3 incorporating a slotless stator 1 is shown in FIG. 1. This is suitable for use in a high speed rotating electrical machine which is used for example at several kW to several tens of kW, and at rotational speeds above several ten thousand rpm.

With the rotating electrical machine 3, the outer shape is formed from a casing 5, and a rotor 7 is rotatably arranged via bearings 9 along a central axis of the casing 5.

With the rotor 7, as shown in FIG. 2, a permanent magnet 11 serving as magnetic field generating device is incorporated therein. This permanent magnet 11 is constructed so that p (where p is an even number of two or more) magnetic poles for generating a magnetic flux in the radial direction, are formed on the outer surface of the rotor 7. For the permanent magnet, a rare earth magnet such as a Sm-Co, Nd-Fe-B sintered magnet is suitable.

The slotless stator 1, as shown in FIG. 1 is arranged around the rotor 7, forming a small gap 13. The slotless stator 1 is one wherein slots for securing windings are not formed. The slotless stator 1 comprises a winding (stator winding, or slotless stator winding) 15 positioned on the rotor 7 side, and a stator core 17 positioned on the casing 5 side.

The stator core 17 is in the form of a hollow cylindrical shape, and is secured so that the outer peripheral face of the stator core 17 is contacted with the inner peripheral face of the casing 5. The stator core 17 is constructed by laminating a large number of ring shaped electrical steel plates in the plate thickness direction. The stator core 17 has an inner peripheral face which is a cylindrical surface not formed with slots. Here the stator core 17 may also be a divided configuration. For example, as shown in FIG. 11, this may be in a two piece form. Of course, this may also be three or more pieces.

The winding 15, as with the stator core 17, is a hollow cylindrical shape, and is secured by means of an insulation layer 19 so that the outer peripheral face of the winding 15 faces the inner face peripheral face of the stator core 17. With the winding 15, the end portions are connected by connection wires via a bus bar 21.

Hereunder is a detailed description of the winding 15.

FIG. 3 shows a condition where the hollow cylindrical shape stator winding 15 has been developed into a plane. This band shape winding 15 developed into a plane comprises a plurality of coil segments 23. The coil segments 23, in the present embodiment correspond to a three phase two pole configuration, and hence there are 3 x 2 = 6 segments. That is to say, in the case where the rotating electrical machine is an m phase p pole configuration, then m x p coil segments are used.

The coil segments 23 are formed from a wire sheaf 27 (refer to FIG. 6) with a plurality of magnet wires (fine wires) 25 composed of conductors bundled together. The magnet wires 25 are formed with an insulation layer on the surface, and the strand outer diameter is preferable less than 1mm. As shown in FIG. 4, the coil segments 23 are constructed by arranging a plurality of single turns 29 formed by winding the wire sheaf 27 once around an approximate rhombic shape. That is to say, the respective turns 29 are wound and arranged so as to be continuously and sequentially shifted in the direction of a diagonal A1 (one diagonal) of a rhombic shape extending in the left and right direction in the figure. The respective turns 29 are arranged contacting with adjacent turns 29 in a close contact condition.

Here instead of the magnet wire 25, a Litz wire may be used in order to reduce the skin effect at high frequencies.

The turns 29 have the following characteristics for the shape. As is apparent from FIG. 4, opposite end portions 35 which are located in the direction of a diagonal (other diagonal) A2 which extends in the vertical direction in the figure, orthogonal to the direction of the one diagonal A1 have bent back portions 37. These bent back portions 37 are formed proceeding so as to project on the other diagonal A2 towards the outside of the turns 29, and then return back in an approximate U-shape and proceed so as to return on the other diagonal A2 towards the inside of the turns 29. That is to say, the bent back portions 37 in this embodiment are in an approximately 180° bent hair pin shape.

Furthermore, with the bent back portions 37, as will be apparent from FIG. 5 being a perspective view of the coil segment 23, these are bent from the lower (upper) side in the figure to the upper (lower) side. That is to say, as described later, when the

coil segments 23 are rolled to give a hollow cylindrical body, these are bent from the inner (outer) peripheral side of the hollow cylindrical body towards the outer (inner) peripheral side. Moreover, at one end portion of the opposite end portions of the respective turns 29 which are located in the direction of the other diagonal A2 which is orthogonal to the direction of the one diagonal A1, the bent back portions 37 are wound from the inner peripheral side of the hollow cylindrical body to the outer peripheral side, and at the other end portion of the opposite end portions of the respective turns 29, are wound from the outer peripheral side to the inner peripheral side.

By forming the bent back portions 37 in this way, two sides 39 of one set are arranged so as to be on a lower side with respect to two sides 41 of the other set. That is to say, when the coil segment 23 is rolled into a hollow cylindrical body, then of the four sides of the approximate rhombic shape coil segments 23, the two sides 39 located on one side of the other diagonal A2 are arranged at the outer peripheral side of the hollow cylindrical body, and the other two sides 41 facing the two sides 39 located on the one side, are arranged on the inner peripheral side of the hollow cylindrical body.

The coil segment 23, is formed from a continuous wire sheaf 27, by continuously winding a plurality of turns 29 (refer to FIG. 4 and FIG. 6). Consequently, a pair of terminals 31 for electrical connection are provided for each coil segment 23.

In FIG. 4 is shown a coil segment where the turns 29 are wound as 12.5 turns. However the number of windings is not limited to this and may be appropriately changed in accordance with the intended use.

As described above, the wire sheaf 27 is constructed with a plurality of magnetic wires 25 bundled together, and as will be apparent from FIG. 6, this wire sheaf 27 has a rectangular shape in cross-section. Furthermore, the wire sheaf 27 is twisted in helical

form. With this twisting, it is desirable to apply at least one twist, that is at least 360°, within the range of one side of the rhombic shape turn 29.

As shown in FIG. 7, each of the magnet wires 25 constituting the wire sheaf 27 is made in a distorted circular cross-section shape. More specifically, these are an approximate square shape having linear portions 33 and bearing rounded corners. Since the magnet wires 25 have this cross-sectional shape, then at the respective linear portions 33, the adjacent magnet wires 25 are contacted in a close contact condition.

By using a plurality of coil segments 23 constructed as described above, a band shape body as shown in FIG. 3 is formed. This band shape body is then rolled into a cylindrical shape as shown in FIG. 9 to give a hollow cylindrical body 43.

Each coil segment 23 is overlapped as follows. That is to say, each coil segment 23, as shown in FIG. 8 is arranged sequentially shifted while being overlapped in the direction of the one diagonal A1. More precisely, two sides 39a of the coil segment 23a arranged at the bottom side (left side) in the figure are arranged adjacent in the direction of the one diagonal A1 to two sides 39b arranged at the bottom side (left side) in the figure of the adjacent coil segment 23b. Furthermore, these are arranged so as to overlap in the vertical direction, the two sides 41c located at the upper side in the figure, of the adjacent coil segment 23c. By arranging in this manner, when the coil segments 23 are formed into a hollow cylindrical shape, the two sides 39 of the coil segments 23, which are arranged on the outer peripheral side are abutted in the circumferential direction against the two sides 39 which are arranged on the outer peripheral side of the adjacent coil segments 23, and are arranged so as to radially overlap the two sides 41 of the adjacent coil segments 23, which are arranged on the inner peripheral side.

The winding 15 made as the cylindrical hollow body 43 (refer to FIG. 9) comprising the plurality of coil segments 23 constructed in the above manner, is inserted inside the stator core 17 as shown in FIG. 10 and secured.

Hereunder is a description of the method of manufacturing the winding 15.

At first, the plurality of magnet wires 25 are bundled together to form the wire sheaf 27 (refer to FIG. 6). The wire sheaf 27 is then wound in an approximately rhombic shape to form a plurality of turns (refer to FIG. 4).

At this time, the wire sheaf 27 is wound so as to form the aforementioned bent back portions 37.

Preferably at the time of forming the turns 29, it is desirable that the wire sheaf 27 is pressed with a press so that the adjacent magnet wires 25 are closely packed together. Moreover, as shown in FIG. 7, it is desirable to form the wire sheaf 27 with a press so as to have a rectangular shape in cross-section.

More preferably, before pressing, it is desirable that the wire sheaves 27 are twisted at least once within the range of one side of the approximate rhombic shape turns 29.

Next, a coil segment 23 comprising a continuous length of the wire sheaf 27 is formed by arranging a plurality of the respective turns 29 so as to be sequentially shifted in the direction of the one diagonal A1 (refer to FIG. 4).

After this, the hollow cylindrical body 43 (refer to FIG. 9) is formed by forming the band shape body (refer to FIG. 8) using a plurality of the coil segments 23 with these coil segments 23 sequentially shifted and overlapped in the direction of the one diagonal A1, and then rolling the band shape body into a cylindrical shape.

In the above manner, the winding 15 is formed.

With the winding 15 according to this embodiment, the following characteristic effects can be demonstrated.

The bent back portions 37 are provided in the winding 15, and these bent back portions 37 are bent in a U-shape in the longitudinal direction of the hollow cylindrical body 43 to give the hair pin shape, and become the end portions of the hollow cylindrical body 43. Therefore, compared to the conventional winding where the winding which is exposed from the stator core extends in the circumferential direction, the amount of magnet wire 25 which is used can be considerably reduced. Since in this way the overall length of the magnet wires 25 is shortened, the direct current resistance of the winding 15 can be reduced, and hence heating of the winding 15 due to joule heating can be suppressed.

Since the bent back portions 37 are bent from the inner (outer) peripheral side of the hollow cylindrical body 43 to the outer (inner) peripheral side, the respective turns 29 can be more tightly arranged. That is to say, since the bent back portions 37 are bent in the radial direction of the hollow cylindrical body 43, these bent back portions 37 can be arranged in close contact in the circumferential direction. As a result, the respective turns 29 also can be closely arranged in the circumferential direction, and even if the number of turns increases, there is no overlapping of the wire sheaves 27 in the radial or axial directions. Since the wire sheaves 27 are not overlapped in the axial direction of the hollow cylindrical body 43, then for example even if the number of turns is increased, the overall length of the winding 15 and consequently the overall length of the rotating electrical machine is not increased. Consequently, a high output due to increasing the amount of conductors can be realized, together with miniaturization of the rotating electrical machine.

Moreover, by bending from the inner peripheral side to the outer peripheral side, the one set of two sides 39 can be arranged on the outer peripheral side, and the other set of two sides 41 can be arranged on the inner peripheral side. Consequently, the wire sheaves 27 can be arranged evenly and close together on both the inner peripheral side and the outer peripheral side of the hollow cylindrical body.

The construction is such that the two sides 39 of the one coil segment coil segment 23, on the outer peripheral side are positioned side by side in the circumferential direction relative to the two sides 39 of the other coil segment 23, on the outer peripheral side, and these are positioned abutting in the radial direction against the two sides 41 on the inner peripheral side of the other coil segment 23. Therefore, the wire sheaves can be arranged evenly and close together in the circumferential and radial directions. Consequently, a sufficiently high current density can be maintained, and a high output thus achieved.

Since the cross-sectional shape of the wire sheaf 27 is an approximate rectangular shape due to pressing, when the plurality of wire sheaves 27 are arranged in a line, these can be arranged so as to have no gap, rather than with the case where a wire sheaf with strands of simple circular cross-section are bundled together. That is, the conductor space factor per one side of the coil segment 23 can be increased.

Since the cross-sectional shape of the magnet wires 25 is made a distorted circular shape such that adjacent magnet wires 25 are closely contacted at the linear portions 33, the conductors can be more densely arranged inside the wire sheaf 27 than with the construction where magnet wires having a circular cross-section is simply bundled together. Hence a higher current density can be obtained.

Since the wire sheaf 27 is made by twisting in a helical shape, an effect the same as conductor reversal in a Litz wire is obtained. In particular this occurs when the rotor 7 of the rotating electrical machine 3 is rotated at high speed. Hence eddy current losses and circulating current losses can be significantly reduced.

Furthermore, by adopting the construction with the helical shape twist, the situation where the wire sheaf 27 becomes loose and out of place, can be avoided.

In particular, in the case of a manufacturing method where, after twisting the wire sheaf 27, this is pressed while applying heat to the wire, the magnet wires 25 are formed in a twisted condition, and hence the bonding together of the respective magnet wires 25 is increased more than by simply pressing. Therefore the wire sheaf 27 can be reliably formed. Consequently, when later forming the turns 29, the cross-section shape of the rectangularly formed wire sheaf 27 can be stably maintained without unraveling. Furthermore, there is no longer the need as heretofore at the time of winding and forming the winding to make this rigid by impregnating a resin such as varnish into the magnet wires 25 and using self bonding wires. Therefore heat dissipation is not impaired by the resin, and a reduction in space factor of the conductors occurring as a result of the resin penetrating into between the magnet wires 24 does not result.

Here with the abovementioned embodiment, the description has been for a construction having an extended portion 50 where the bent back portions 37 proceed along the other diagonal A2 towards the outside of the turns 29 and then return back in an approximate U-shape and proceed along the other diagonal A2 in the direction towards the inside of the turns 29 (refer to FIG. 4). However even if this extended portion 50, as shown in FIG. 12 is constructed so as to be located on an extension in the extension direction of either side of the two sides containing the bent back portions 37,

of the four sides of the approximate rhombic shape turns 29, the above effect is not impaired. Furthermore, a construction having simply a bent back end portion with the extended portion 50 omitted is also possible.

As described above, with the present invention, since the bent back portions are provided at opposite ends of the respective turns, the respective turns can be tightly wound. As a result, a high current value can be realized, and a high output from the rotating electrical machine can be achieved.

Furthermore, since the bent back portions can be arranged sequentially aligned in the circumferential direction, a size increase in the axial direction and the diametral direction due to an increase in the amount of conductors can be avoided. Hence miniaturization of the rotating electrical machine can be realized.

Since the construction is such that the wire sheaf is twisted in a helical shape, eddy current losses and circulating current losses produced at the time of high speed rotation of the rotating electric machine can be considerably reduced. Moreover this can also cope with increased speeds.

By adopting the method of manufacturing the wire sheaf by pressing, the cross-sectional shape of the wire sheaf can be stably maintained. Therefore the degree of freedom at the time of winding manufacture can be considerably increased.

CLAIMS:

1. A stator winding for use in a rotating electric machine having a slotless stator, being a hollow cylindrical body formed by:

forming turns by winding a wire sheaf of a plurality of fine wires composed of conductors bundled together, through one turn in an approximate rhombic shape;

forming approximate rhombic shape coil segments comprising a continuous length of said wire sheaf by winding and arranging a plurality of said turns so as to be sequentially shifted continuously in the direction of one diagonal of said rhombic shape,

forming a band shape body using a plurality of said coil segments with these coil segments sequentially shifted in the direction of said one diagonal and so as to be adjacent to each other, and rolling said band shape body into a cylindrical shape.

2. A stator winding according to claim 1, wherein with said wire sheaf, one end portion of opposite end portions of said respective turns which are located in the direction of an other diagonal orthogonal to the direction of said one diagonal is wound from an inner peripheral side of said hollow cylindrical body to an outer peripheral side, and an other end portion of said opposite end portions of said respective turns, is wound from the outer peripheral side to the inner peripheral side.

3. A stator winding according to either one of claim 1 and claim 2, wherein with said respective turns, opposite end portions which are located in the direction of an other diagonal orthogonal to the direction of said one diagonal, have bent back portions which

proceed so as to project towards an outside of said turn, and then return back in an approximate U-shape and proceed so as to return towards an inside.

4. A stator winding according to any one of claim 1 through claim 3, wherein said respective turns are arranged in a condition touching adjacent turns.

5. A stator winding according to any one of claim 1 through claim 4, wherein of the four sides of said approximate rhombic shape coil segments, two sides located on one side of said other diagonal are arranged on an inner peripheral side of said hollow cylindrical body,

and the other two sides opposite to the two sides located on said one side are arranged on an outer peripheral side of said hollow cylindrical body.

6. A stator winding according to claim 5, wherein the two sides of the coil segment which are arranged on the inner peripheral side are abutted in the circumferential direction against said two sides which are arranged on the inner peripheral side of the adjacent coil segment,

and the respective coil segments are arranged sequentially shifted while being overlapped so as to radially overlap said two sides of the adjacent coil segments, which are arranged on the outer peripheral side.

7. A stator winding according to any one of claim 2 through claim 6, wherein said bent back portions are bent from the inner peripheral side of said hollow cylindrical body

towards the outer peripheral side, or from the outer peripheral side towards the inner peripheral side.

8. A stator winding according to any one of claim 1 through claim 7, wherein said wire sheaf is twisted at least one turn in a helical form within a range of one side of the respective approximate rhombic shape turns.

9. A stator winding according to any one of claim 1 through claim 8, wherein said wire sheaf has an approximately rectangular shape cross-section.

10. A stator winding according to any one of claim 1 through claim 9, wherein said fine wires have a distorted circular cross-section with linear portions, and adjacent fine wires are contacted at said linear portions.

11. A method of manufacturing a stator winding wherein with a method of manufacturing a stator winding used in a rotating electric machine having a slotless stator, which incorporates:

a turn forming step for forming turns by winding a wire sheaf of a plurality of fine wires composed of conductors bundled together, through one turn in an approximate rhombic shape;

a coil segment forming step for forming coil segments comprising a continuous length of said wire sheaf by winding and arranging a plurality of said turns so as to be sequentially shifted continuously in the direction of one diagonal of said rhombic shape; and

a hollow cylindrical body forming step for forming a band shape body using a plurality of said coil segments by overlapping these coil segments so as to be sequentially shifted in the direction of said one diagonal and adjacent to each other, and rolling said band shape body into a hollow cylindrical shape,

said turn forming step includes a step where with said wire sheaf, one end portion of opposite end portions of said respective turns which are located in the direction of an other diagonal orthogonal to the direction of said one diagonal is wound from an inner peripheral side of said hollow cylindrical body to an outer peripheral side, and an other end portion of said opposite end portions of said respective turns, is wound from the outer peripheral side to the inner peripheral side.

12. A method of manufacturing a stator winding according to claim 11, wherein said turn forming step incorporates a bent back portion forming step for forming bent back portions at opposite end portions of said respective turns which are located in the direction of the other diagonal orthogonal to the direction of said one diagonal, which proceeds so as to project towards an outside of said turn, and then returns back in an approximate U-shape and proceeds so as to return towards an inside.

13. A method of manufacturing a stator winding according to either one of claim 11 and claim 12, wherein said turn forming step incorporates a press step for pressing said wire sheaf so that adjacent fine wires are closely contacted.

14. A method of manufacturing a stator winding according to claim 13, wherein prior to said press step there is provided a step for twisting said wire sheaf at least one turn in a helical form within a range of one side of said approximate rhombic shape turn.

15. A method of manufacturing a stator winding according to either one of claim 13 and claim 14, wherein said press step incorporates a step for forming said wire sheaf so that said wire sheaf has an approximately rectangular cross-section.

ABSTRACT

To provide a stator winding which copes with high output and miniaturization, then with a stator winding, turns formed by winding a wire sheaf of a plurality of fine wires bundled together, in an approximate rhombic shape, are arranged so as to be sequentially shifted in the direction of one diagonal of the rhombic shape, to thereby form an approximate rhombic shape coil segment comprising a continuous length of the wire sheaf. A plurality of coil segments are then sequentially shifted and overlapped on one diagonal to form a band shape body, and a hollow cylindrical body is then formed by rolling the band shape body into a circular shape. The winding is characterized in that with each turn, opposite end portions located in the direction of an other diagonal orthogonal to the direction of the one diagonal have U-shape bent back portions.

FIG. 1

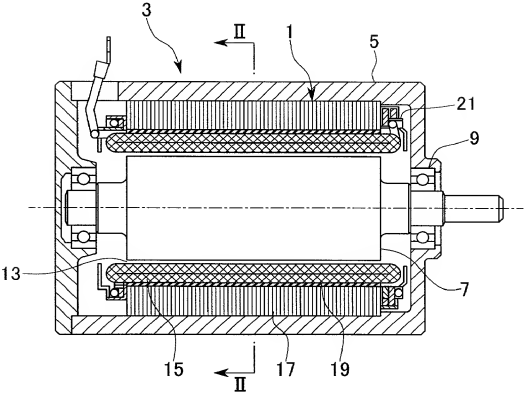


FIG. 2

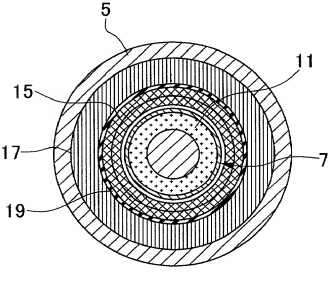


FIG. 3

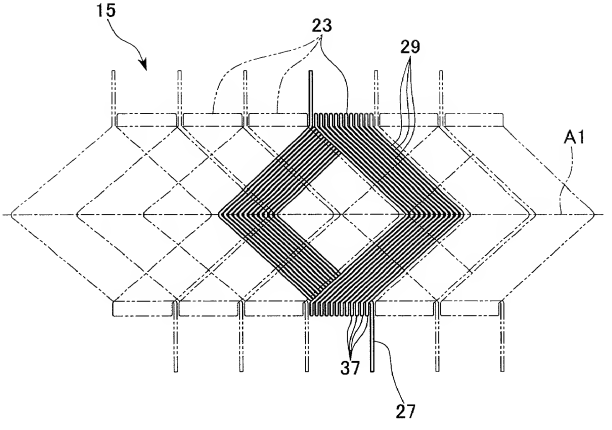


FIG. 4

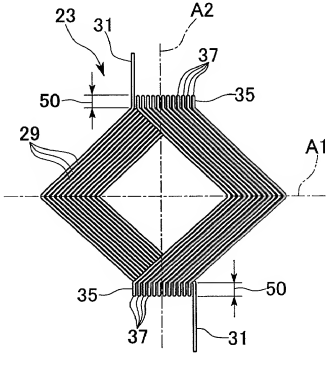


FIG. 5

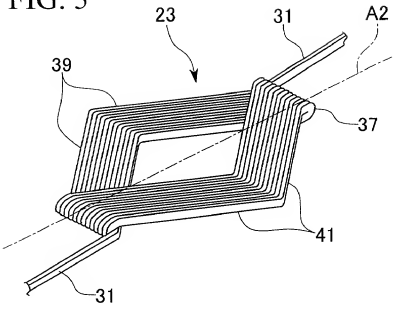


FIG. 6

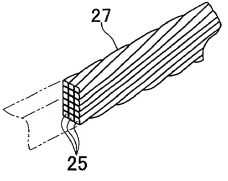


FIG. 7

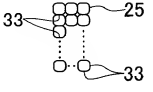


FIG. 8

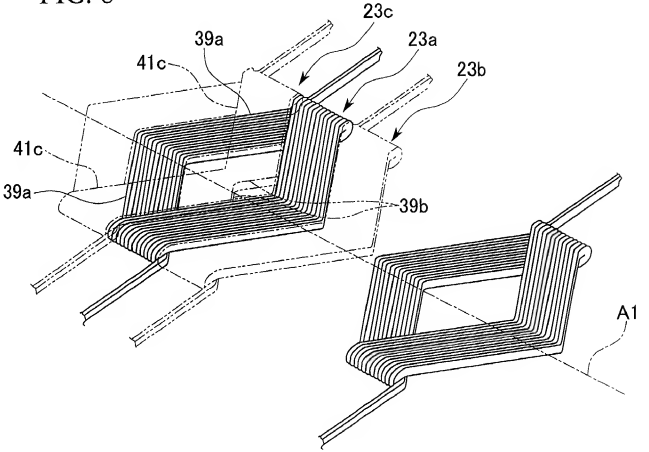


FIG. 9

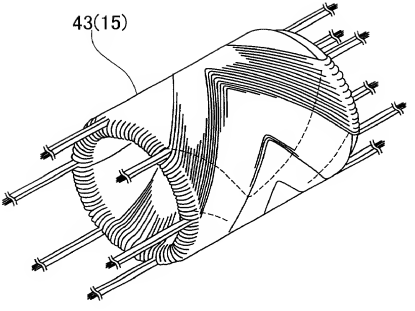


FIG. 10

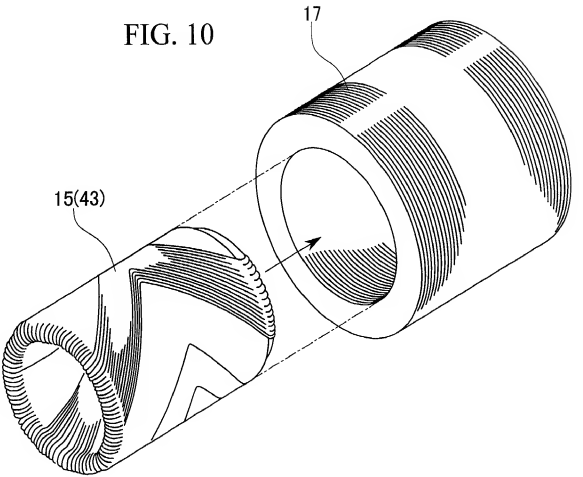


FIG. 11

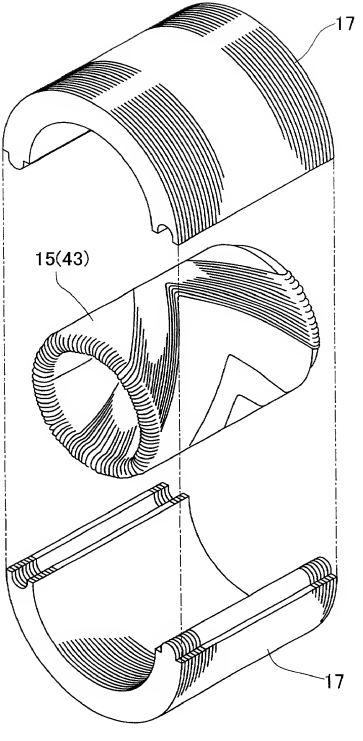


FIG. 12

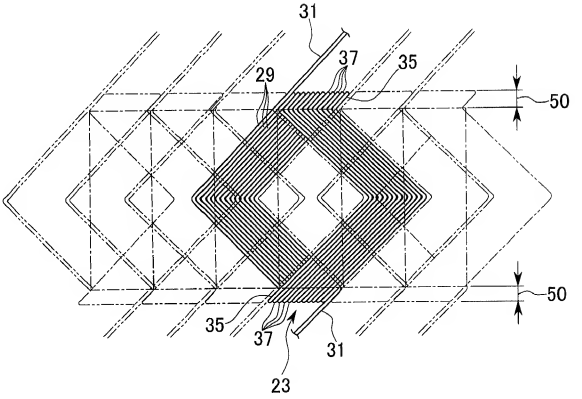


FIG. 13

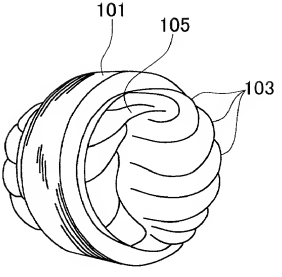


FIG. 14

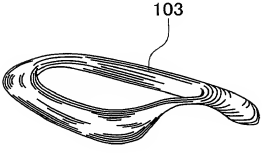


FIG. 15

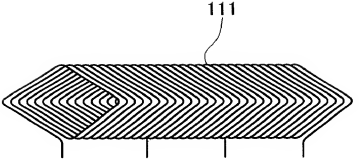
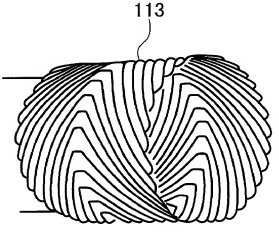


FIG. 16



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SIP-106-A PTO/SB/105 (8-96)
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Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

STATOR WINDING AND MANUFACTURING METHOD THEREFOR

上記発明の明細書（下記の欄でX印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☐ __月__日に提出され、米国出願番号または特許協定条約国際出願番号を_____とし、
（該当する場合）_____ に訂正されました。

☐ was filed on _____
as United States Application Number or
PCT International Application Number
_____ and was amended on
_____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第３７編第１条５６項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

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Japanese Language Declaration
(日本語宣言書)

私は、米国法典第３５編１１９条(a)-(d)項又は３６５条(b)項に基き下記の、米国以外の国の少なくとも一ヵ国を指定している特許協力条約３６５(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Not Claimed 優先権主張なし
Patent 11-211395	Japan	26/07/1999	☐
			☐

私は、第３５編米国法典１１９条(e)項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

私は、下記の米国法典第３５編１２０条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約３６５条(c)に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第３５編１１２条第１項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第３７編１条５６項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、保属中、放棄済)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第１８編第１００１条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Japanese Language Declaration
(日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith *(list name and registration number)*

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第二共同発明者	日付	Second inventor's signature Takeo Fukuda	Date July 3, 2000
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私書箱		Post Office Address	c/o K.K. Hon-da Gijutsu Kenkyusho,
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（第三以降の共同発明者についても同様に記載し、署名をすること）

(Supply similar information and signature for third and subsequent joint inventors.)